Testing System of Servo Valve Flow Characteristics

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Abstract Electro-hydraulic servo valve widely used in servo system is one key component translated electronic signal to hydraulic signal. The servo valve capability influences the character of servo system directly. Flow characteristic is one important performance index judging servo valve capability. To master their characteristic, must do many experiments. Virtual instrument technology is adopted in one testing system of Servo Valve Flow Characteristic; soft measure method can test steady-state flow and instantaneous dynamic flow; all test data can be on-line processing, storage and printed. According to testing result, the valve flow characteristic can be calculated automatically. Rationality and reliability of this testing system is verified by practical test and contrast experiment

Keywords: electro-hydraulic servo valve virtual instrument flow characteristic

1. Introduction

Much modern complex weapon equipment equips hydraulic servo system. It is a difficult problem faced to maintenance artisans how to assure those systems run truly and effectively. Electro-hydraulic servo valve is the kernel components of electro-hydraulic servo system. Their capability directly touches control accuracy, stability and reliability. Therefore, hard and fast performance testing to electro-hydraulic servo is an importance task to ensure equipment production, repairs and maintenance. This paper introduces the design feature and technique of one testing system countered some electro-hydraulic servo valve of one antiaircraft gun servo device. This system based on virtual instrument technique have much advantage, such as conveniently developed capability, powerful function, brief operation, high reliability application and capacious development.

2. Characteristic of electro-hydraulic servo valve

Characteristic of electro-hydraulic servo valve include static characteristic and dynamic characteristic.[1]

Generally, characteristic analysis of electro-hydraulic servo involves pressure characteristic, flow characteristic and step response and so on.

2.1 Static characteristics

Static characteristic analyses of electro-hydraulic servo valve include load pressure -load flow characteristic and Load pressure-load flow characteristic shows the relationship among input current I_L, load flow Q_L and load pressure P_L during stable state.[2] It is the most important static characteristic and the major foundation to select electro-hydraulic servo valve.

Input current-load flow characteristic is also renamed by unloaded flow characteristic. It shows the relationship between output flow and input electronic current when P_L is 0.

2.2. Dynamic characteristic

Dynamic characteristic testing of electro-hydraulic servo valve include transient behavior and frequency characteristic.

Transient capability is reflected by step response. In step response experiment, incoming signal may be step signal controlling input or load step signal. Output signal is the dynamic response to input signal. The dynamic response curve can be attained through the experiment.

Frequency characteristic of electro-hydraulic servo valve can be attained by frequency response experiment. When load pressure is 0, input current is frequency conversion sine wave whose amplitude is constant, output flow will change according to the

same frequency sine rule. Here, the relationship between amplitude ratio of output flow and frequency of output flow as well as relationship of frequency and the phase difference between output flow and input current is the frequency characteristic of electro-hydraulic servo valve.

3. Design and construction of the testing system

3.1 Component

The function of this system is demanded to finish testing static characteristic and dynamic characteristic of electro-hydraulic servo valve. Ground on above-mentioned function and testing demand, we adopted virtual instrument technique to design the testing system instead of many traditional instruments. Testing system consist of hydraulic test bed（install hydraulic component, 、 pipeline, sensor, display instrument, state optional switch and so on）and the test and control system whose kernel is industrial computer. The test and control system involve test and control box, computer, and measure and management software. Fig.1 shows the block diagram of the testing system

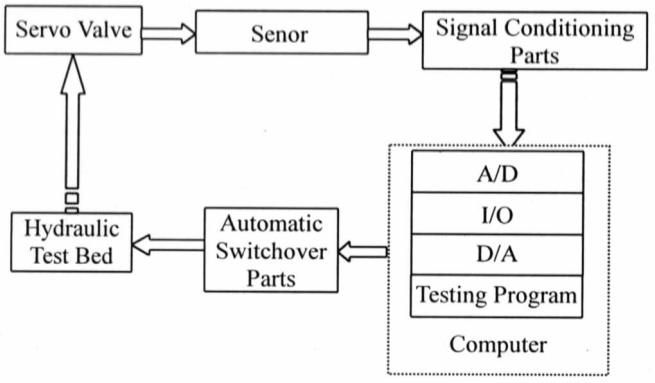

Fig.1 Block diagram of the testing system

3.2 Hardware design

The testing system of servo valve is designed to measure the static characteristic and dynamic characteristic of electro-hydraulic servo valve. Computer and flexo DA board is the base kernel. Others include hydraulic test bed, senor, signal conditioning parts, test and control box, signal cable.

3.2.1 Hydraulic test bed

Hydraulic test bed is the operation floor on which to fix valve to be tested, hydraulic pipeline, pump, and senor. It consists of hydraulic pump; overflow valve; rapid valve; selector valve and load oil cylinder.

3.2.2 senor

During the testing of servo valve, physical quantity need to be measured include pressure, flow, voltage, electrical current, velocity and so on. The selection of flow senor is the key of testing. In consideration of the demand about dynamic flow testing. We select high-pressure duplexing gear flowmeter to measure flow of valve. At the same time, precision, using environment, price are also considered

3.2.3 Signal conditioning parts

In this section, signals of different categories are transformed, which makes preparation for data acquisition. It is composed of one-time instrument circuit, sensor circuit, signal filter circuit and separation circuit, which render the irregular signals into regular ones fitting A/D working requirement

3.2.4 Automatic switchover parts

The switchover parts utilize I/O channels, coding buffering, driver circuit and IC relay controlled by computer to fill the acquisition of signals from different route at different time. Testing and control system put control signal into actuator by D/A changer and signal conditioning parts to control hydraulic test bed and then satisfy the testing demand of servo valve.

3.2.5 Multi-function data acquisition board

It is through data acquisition board of the hardware, that signals are picked up and offered to different software to be analyzed, thus perform the function of various special devices. It consists of A/D changes, D/A changes, I/O disjunctor, interruption IRO, DMA, and so on. Its can be connected either to PCXT/AT bus or to PCI bus. The board integrates A/D, D/A, I/O

and IRO, connecting the main frame and other parts. Together with signal changing and signal switchover it turns into the changeable channel data acquisition system. A/D changes, adopting AD574A, can ensure resolution ratio 12 bit and conversion rate 25 μs, thus meeting the requirements of precession in most cases. It can connect a lot of computer bus for its change results go through tristate buffer. D/A channels comprise 74LS245, 74ls374 chips. It controls the direction of digital amount by means of address coding circuit. While controlling signal switchover through coder and driver, it can also be compatible with outer reading of digital signal. IRO is set to control real strong signal to oblige different test needs.

3.3 Testing software

In essence, the VI technique makes full use of software development. So, instrument software is the core of the integrative detecting instrument. It integrates human-computer interface, data acquisition and processing, data analysis, signal output and control to enable itself to exploit several general apparatuses. In the course of the software, the VI is made to function as the tradition ones, integrating performance check and fault diagnosis of several typical equipment. Given certain hardware, the overall inspection and fault diagnosis of equipment of categories relies on programming. The software system consists of 3 parts: drivers, virtual panel and application program. Fig.2 shows the component of testing system software.

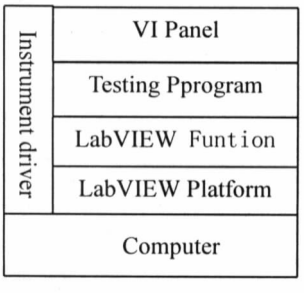

Fig.2 Component of testing system software

We usually have two methods to program. One is traditional which makes of advanced language such as VC++, VB, Delphi, the other is special, which, using LabVIEW by National Instrument (NI) or HP-VEE by HP company. Here we take admixture between VC++ and LabVIEW to program.

3.3. Virtual Panel of testing System

It is the connecting parts between the device and the consumer. The control of the process of testing and diagnosis is virtually that of the panel. We compile the panel program by LabVIEW. With different equipment there is different diagnosis project. The panel assumes several forms, but mainly is composed of 3 windows: control windows, on which there are various switches and buttons similar to the traditional ones, they are used by the consumer to control the device; display windows, which dynamically display data and waves in the course of testing; data windows, which is used to show the test result.

3.3.2 Instrument Drivers of detecting system

Although LabVIEW gives a lot of DA subprograms ranging from simple to advance, they support only DAQ board by NI and a few other DA boards supporting LabVIEW platform developed by other companies. To use general DA board, we have to develop our instrument drivers, that is, dynamic link library (DLL) to fulfill the function of general DA board. Under Win98 operating system, the DLL, which gets library function from LabVIEW must be 32 bit. So under Borland C++ 5.0, we set up 32-bit project file by the extension of .DLL by means of integration development (IDE). Finally DLL is completed by the compilation of project file. To different acquisition purpose, we need only programming differently in DLL to gather data though the interface and function of LabVIEW.

3.3.3 Testing program

The testing system uses the VI technique, with its application programs showing its functions and characteristics. The application programs include signal-processing program, testing program and control program of hydraulic test bed.

Signal processing program is compiled by means of VC++. At the same time various signal processing modules such as Fourier transform, power spectrum analysis, matrix operation, provided by integration

software package in LabVIEW are used to analyze and process signal. When various virtual panels designed are using different DA programs and signal processing programs, it can display the wave and analyze the spectrum as done traditionally, hence the typical VI come into being. Here we choose to establish 3 common-used detecting instruments: digital oscillograph, signal generator and spectrum analyzer.

The testing and control program is to automatically test the equipment of different performance. Given the reliability, in the course of programming, fault tolerance processing software is developed besides interface, signal acquisition and signal output control and data processing. The fault tolerance program utilizes data matching and password reply. I/O channels code keys when we are to operate a certain key. The code number is sent out by "out", then through coding circuit. When the indicating light flashes, the key can be operated. When the operation is over, the operating key code number is read into the computer by "IN" and recognized, and only when OUT/IN are in accordance with the numbers can the program work on to fulfill respective detecting program, otherwise the computer will give out alarming signal, pointing out an improper operation. Being not demanding what so even, the program assures the correct and safe system operation at a large margin.

4. Conclusion

The testing system of servo valve adopted virtual instrument technique test flow characteristic availably. It can analyze the testing data and compute the index estimate capability of servo valve automatically. The rationality and reliability of this system is tested and verified by reality testing and contrast experiment.

Acknowledgment

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